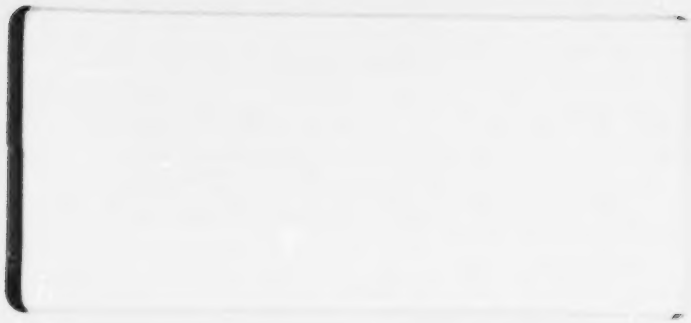


Manitoba
Environment
and Workplace
Safety and Health

1G-8159

MANITOBA NETWORK FOR

PRECIPITATION COLLECTION (M.N.P.C.)

DATA SUMMARY - 1984

D. Bezak, T. M. Rae

Air Standards and Studies

Environmental Management Division

Report No. 87-2
December 1987

Bezak D., Rae, T. M., 1987. Manitoba Network for Precipitation Collection (M.N.P.C.) Data Summary - 1984, Manitoba Department of Environment And Workplace Safety and Health, Air Standards and Studies Section, Report No. 87-2. pp. 44.

ABSTRACT

Precipitation samples were collected at four monitoring sites in northern Manitoba: Island Lake, Norway House, Gillam, Brochet, and one southern location: Pointe du Bois during the period of January 1 to December 31, 1984 as an ongoing part of the Manitoba Network for Precipitation Collection programme. The purpose of the programme is to monitor and analyse collected precipitation samples to determine the quality of precipitation within the boundaries of Manitoba.

Sulphate was found to be the predominant paramater at all monitoring locations with calcium second. The yearly wet sulphate deposition values at all sites were well below the Eastern Canada guideline level of 20 kilograms per hectare per year and ranged from 4.88 to 6.00. The yearly volume-weighted mean pH at all sites varied from 4.74 at Brochet to 5.08 at Pointe du Bois.

TABLE OF CONTENTS

		Page
	Abstract	i
	Table of Contents	ii
I	Introduction	1
II	Sampler Operation	2
III	Network Expansion	4
IV	Results	4
V	Discussion of Results	5
	A. Island Lake	7
	B. Norway House	10
	C. Gillam	11
	D. Brochet	13
	E. Pointe du Bois	14
VI	Conclusions	16
VII	Glossary	17
	Appendices	19
	A. Monitoring Site Locations (Map)	19
	B. Daily Precipitation Summary (by station)	21
	C. Yearly Statistical Data Summary (by station)	30
	D. Graphical Presentation of Monthly Average pH (by station)	33
	E. Historical Data Summary of Precipitation Statistics 1980-84	39
	F. Precipitation Event Type Code	41
	G. Extraneous Matter Code (visual inspection)	43

I. INTRODUCTION

The collection and monitoring of precipitation in Manitoba has been on-going by the Manitoba Network for Precipitation Collection (M.N.P.C.) since the fall of 1980. The Federally sponsored Canadian Network for the Sampling of Precipitation (CANSAP) began monitoring precipitation in Manitoba in 1977. The M.N.P.C. programme has attempted to: 1) provide a sufficient base data to determine the quality of precipitation with emphasis on acidic substances, 2) to offer verifiable precipitation chemistry data to other jurisdictions, 3) to determine any spatial or temporal trends in precipitation chemistry related to industrial and/or meteorological conditions within the boundaries of Manitoba.

This document presents data accumulated during the period of January 1 to December 31, 1984 from the M.N.P.C. monitoring network stations located at: Island Lake (lat. 53° 52'N., long. 94° 40'W.), Norway House (lat. 54° 00'N., log. 97° 48'W.), Gillam (lat 56° 21'N., long. 94° 40'W.), Brochet (lat. 57° 54'N., long. 101° 41'W.), and Pointe du Bois (lat. 50° 18'N., long. 95° 33'W.). A broader overview of the M.N.P.C. network providing site descriptions and programme procedures has been presented under the title, "Manitoba Network for Precipitation Collection (M.N.P.C.) - An Overview", available from the Department of Environment and Workplace Safety and Health.

II. SAMPLER OPERATION

The precipitation collectors utilized within the monitoring program were:

A. Island Lake:

- Automated Sangamo Type A — Oct. 1980 to Dec. 12, 1983
- Meteorological Instruments Company (Type A-1) — Dec. 12, 1983 to present

B. Norway House:

- Automated Sangamo Type A — Oct. 1980 to Jan. 9, 1984
- Meteorological Instruments Company (Type A-1) — Jan. 9, 1984 to present

C. Gillam:

- Meteorological Instruments Company (Type A-1) — Dec. 19, 1983 to present

D. Pointe du Bois:

- Meteorological Instruments Company (Type A-1) — Jan. 2, 1984 to present

E. Brochet:

- Meteorological Instruments Company (Type A-1) — Feb. 8, 1984 to present

Both samplers operations are based on similar principles. A sensing arm extending away from the instrument houses two sensor boards, which, in the absence of precipitation, have an open circuit. In this mode, the mechanical lid is closed over the "wet" collection bucket. At the onset of precipitation, any moisture striking the sensor boards closes the circuit and through a series of gears the lid traverses across the instrument, exposing the "wet" collection bucket to the precipitation. At the cessation of the precipitation, automatic heaters dry the sensor board and the cycle is reversed.

Previously, the samples were transferred from the collection bucket (Automated Sangamo Type A) to an acid washed 250 mL polyethylene bottle and subsequently shipped to the Technical Services Laboratory in Winnipeg. Concurrent with the incorporation of the new samplers (Meteorological Instruments Co.) into the network was the use of clear plastic bags as the means to catch the precipitation. These bags, manufactured from Dupont A-188 resin were supplied to the monitoring stations on a monthly basis. The bags were custom ordered in two dimensions; for winter collection 9.9 cm. x 118 cm., and for summer collection, 9.9 cm. x 53.3 cm. A comprehensive analytical screening process was conducted on several samples of bags to ensure purity from low level contamination before the Dupont resin was chosen. This "screening" process is continued on each lot of bags shipped to the station. The utilization of plastic bags has reduced the number of possible introductions of contaminants to the sample by eliminating sample transfer steps between collection and analysis. Samples received by the laboratory are analyzed for the following parameters; 1) pH, 2) acidity, 3) sulphate, SO_4, 4) nitrate-nitrogen, NO_3-NO_2-N, 5) ammonia, NH_3-N, 6) chloride, Cl, 7) calcium, Ca, 8) magnesium, Mg, 9) sodium, Na, 10) potassium, K. The order indicates priority.

Data was archived using a fourth generation computer language (FOCUS). Calculated yearly volume-weighted mean pH, SO_4, and NO_3 values and yearly wet sulphate deposition constitute some of the major data outputs.

III. NETWORK EXPANSION

The original M.N.P.C. network was established in two areas, i.e. Island Lake, Norway House, predominately downwind of the non-ferrous smelter operations in northern Manitoba. It was determined, however, that these two monitoring locations could not provide realistic or definitive data with respect to the quality of precipitation in relation to the spatial area of the Province. To meet this goal, the network was expanded in the Winter of 1983-84. Utilizing specific monitoring site criteria, three additional locations were chosen: namely, Gillam (December 19, 1983), Brochet (February 8, 1984) and Pointe du Bois (January 2, 1984). A more complete site description and the criteria utilized for their selection is included under the title, "Manitoba Network for Precipitation Collection (M.N.P.C.) - An Overview", available from the Department of Environment and Workplace Safety and Health.

IV. RESULTS

Precipitation quality results, associated physical measurements and related statistics are shown as below in the attached appendices:

Appendix B

- A detailed summary showing information for each daily precipitation sample collected by sampling site for the 1984 period.

Appendix C

- A statistical summary of precipitation quality for each sampling site for the 1984 period.

Appendix D

- A graphical representation of monthly averaged pH for each sampling site for the 1984 period.

Appendix E

- An historical summary of some precipitation statistics since the network's inception to 1984 for all sampling sites.

Appendix F

- Precipitation Event Type Coding.

Appendix G

- Extraneous Matter Coding (visual inspection).

V. DISCUSSION OF RESULTS

Though it was the intent within the design of the sampling network to locate monitoring sites that would be representative of regional areas and to adopt collection and analytical procedures that are common to other networks, it should be noted that the data presented in this report may have limitations and caution should be exercised when utilization of the data is warranted. In particular, since all data collected within the network is reported, attention might be focused toward:

1. Possible non-representativeness of some monitoring locations - reference should be made to the report "Manitoba Network for Precipitation Collection - An Overview" for deviations from generally accepted siting criteria.
2. Collection efficiencies - the inherent design of the sampling instrumentation combined with operational practices and the nature of the precipitation event (eg. light snow) has contributed in several instances toward sample collection that is incomplete and represents only a part of the total event. The inference from the analyzed characteristics to actual conditions may be minimized.
3. Ionic balances - since most precipitation samples were analyzed for both major anions and cations, it would be expected the analytical mass discrepancies between the two should be minimal. However, in many cases, this is not true and could be due to a number of reasons including analytical levels being close to the analytical detection levels of the instrumentation where relative errors are highest, analytical levels being below detection levels and where estimates had to be made to complete the ion balance calculation, or actual changes in the chemical properties of the sample during the time period of the sample analysis.

4. Limited quality assurance practices - during 1984 quality assurance procedures were only in the infancy of development and, therefore, were somewhat limited in application, particularly in relation to field sampling. Laboratory performance in peer-sponsored round-robin quality assurance surveys was generally acceptable but very few of the "blind samples" were used to test the accuracy of the total analytical stream. Information on laboratory operations in support of precipitation sample analysis is available. (Fritz, D.L. "Summary of Activities Relating to Laboratory Aspects of the Manitoba Network for Precipitation Collection in 1984"), available from the Department of Environment and Workplace Safety and Health.

A. ISLAND LAKE

During the report period (January 1 to December 31, 1984) the Atmospheric Environment Service weather station, collocated on Stevenson Island with the M.N.P.C. precipitator collector, reported a total precipitation fall of 542.0 mm from 136 events. Since not all events are analyzable due to insufficient volume during collection, the collectible fraction translated to 527.5 mm from 91 events (Appendix C, Table 1.0, shown as "AES COUNT").

The M.N.P.C. precipitation sampler collected a total precipitation volume of 25.0 litres (calculated with a collection vessel diameter of 279 mm) for a total precipitation fall of 409.4 mm from 84 events for a collection efficiency of 78.1%.

The M.N.P.C. program analyzes only samples with sufficient volumes to undertake a complete analysis of 10 physical/chemical parameters. This minimum cut-off point was established internally between the W. M. Ward Technical Services Laboratory in conjunction with M.N.P.C. staff. The "minimum analyzable volume" was established to be 50 mL which corresponds to a precipitation event of 0.8 mm or greater (on the basis of a collector vessel having a cross sectional area of 613.12 cm^2).

The efficiency of the program to collect precipitation at Island Lake (collection efficiency) was 78.1% when compared to the total fall that should have been collected with the sampler and was 75.4% when compared to the total of all precipitation that had fallen at the site (representative collection efficiency) from events measuring 0.2 mm or greater.

Of the total precipitation reported, 65.2% fell during the months of June to October, with June recording the highest total precipitation of 101 mm (18.7%) during the report period. The lowest reported total precipitation of 2.4 mm (0.4%) was in the month of March.

Of the total 84 events collected by the M.N.P.C. instrument, 40 (47.6%) were rainfall, 26 (30.9%) were snowfall, and the remaining 18 (21.4%) were reported as either a combination of both or a different event type such as hail or freezing drizzle. (Reference Appendix F.). The efficiency of the M.N.P.C. sampler to collect snowfall (49.0%) was significantly lower than that for rainfall or combinations thereof, (84.2%). For the purposes of this report, winter is classified from the months of November 1983 to April 30, 1984. Summer is May 1 to October 31, 1984.

The pH of precipitation collected at Island Lake ranged from a low of 4.06 (April 12, 1984) to a high of 7.19 (May 18, 1984). The overall annual volume-weighted mean pH was 4.91 which represents a decrease from 1983 but higher than years prior to 1983. Monthly averaged pHs as shown in Appendix D indicate a decreasing trend throughout the course of the year.

The volume-weighted mean of sulphate was 0.83 mg/L; this level represents a decrease from previous years where averaged sulphate levels in the range of 0.68 to 1.12 were recorded. The corresponding calculated wet sulphate deposition for the year was 4.88 kilograms per hectare; this level as well represents an apparent significant decrease from previous years.

Nitrate levels in 1984 at Island Lake averaged to be 0.54 mg/L; this also is a decrease from the earlier years within the network.

From values of eight paramaters calculated throughout the 1984 report period an indication of the dominant ion which constitutes the composition of the collected precipitation is indicated. At Island Lake, for 1984 the dominant ion was sulphate, followed by ammonium. The remainder of the sequence is as follows:

$$SO_4 > NH_3 > Cl > Ca > NO_3 > K > Na > Mg$$

This order of priority for 1984 has varied when compared to the 1983 sequence, however, the dominant species remains sulphate:

$$SO_4 > Ca > Na > NH_3 > Mg > Cl > NO_3 > K$$

These values are mean values and possible sample contamination or meteorological conditions which could influence any or all of these was not considered.

B. NORWAY HOUSE

During the report period, the Atmospheric Environment Service weather station, located at the airport reported a total precipitation fall of 498.0 mm from 152 events. The "collectible fraction" translated to 482.0 mm from 99 events (Appendix C, Table 2.0, shown as "AES COUNT").

The M.N.P.C. collector, situated on an island approximately 16 Km away from the weather station, began operations January 9, 1984 and collected 16.2 L for a total precipitation fall of 265.12 mm from 66 events. This translates to an overall collection efficiency of 55.8% and a representative collection efficiency of 53.0% based on all events recorded greater than 0.2 mm. Of the total precipitation collected, 73.9% fell during the months of May to November with October recording the highest precipitation of 83.5 mm (16.8%). The lowest recorded precipitation fall was in December with a fall of 13.6 mm (2.7%). Rain constituted 34 (51.5%) of the events, snow constituted 21 (31.8%) of the events and the remaining 11 events (16.6%) were either a combination of both or another event type (Appendix F).

The efficiency of the sampler to collect snowfall (34.9%) was significantly lower than the instrument's ability to collect rainfall (57.5%).

The pH of precipitation collected at Norway House ranged from a low of 4.17 (October 16) to a high of 7.0 (April 7).

The overall volume-weighted mean pH of 4.87 is a decrease from the 1983 report period (5.16) but similar to years prior to 1983. See Appendix E "Data Summary M.N.P.C. Network - 1980-84.

Monthly averaged pH show a fluctuating tendency with a perceived downward trend over the course of the year (See Appendix D, "Mean pH - Norway House).

The volume-weighted mean sulphate was 1.21 mg/L; a value which corresponds with values from previous years which ranged from .6 to 1.29 mg/L. The corresponding calculated wet sulphate deposition value of 6.00 Kg/ha/yr is lower than corresponding values from previous years.

Nitrate levels at Norway House for 1984 were calculated to be .63 mg/L which is a significant reduction based on previous years.

Through the 1984 report period, the dominant or most prevalent parameter was sulphate with a mean value of 1.21 mg/L. The parameter sequence was as follows:

$SO_4 > NH_3 > Ca > Cl > NO_3 > K > Na > Mg$

This sequence is similar to 1983, however, inasmuch as all the parameters made a one step shift:

$SO_4 > Ca > NH_3 > NO_3 > Cl > K > Mg > Na$

C. GILLAM

During the report period, the Atmospheric Environment Service weather station, located at the airport, reported a total precipitation fall of 392.0 mm from 145 events. Since not all events were analyzable due to insufficient volume, the collectible fraction translated to 376.0 mm from 83 events (Appendix C Table 30, shown as "AES COUNT").

The M.N.P.C. precipitation sampler located at the Manitoba Hydro's Radisson Convertor Station, started operation on December 19, 1983 and collected a total precipitation fall of 81.1 mm for an overall collection efficiency of 22.0%. Of the total precipitation collected 58.6% fell during the months of May to September with July recording the highest precipitation of 69.2 mm (17.7%). The lowest precipitation fall was recorded in March with a volume of 6.6 mm (1.7%).

Rainfall accounted for 33% of the events collected while snowfall accounted for 36.0%; the remaining 8 events were a combination of these or a different event type (Appendix F).

The pH of precipitation collected at Gillam ranged from a low of 4.43 (February 8) to a high of 7.39 (July 30). The overall volume-weighted mean pH was 5.17. The volume-weighted mean sulphate value was 1.48 mg/L which corresponds to a calculated wet sulphate deposition of 5.80 Kg/ha/yr. The mean nitrate value was calculated to be 0.82 mg/L for the report period.

At Gillam for 1984 the dominant ion was sulphate with a mean value of 1.48 mg/L. The remainder of the ions in sequence are:

SO_4 > Ca > Cl > Na > Mg > NH_3 > NO_3 > K

Since this is the first year of monitoring at the Gillam site, it is difficult to predict any trends or indicators based on the data collected. Numerous mechanical breakdowns contributed significantly to the poor overall instrument performance for 1984.

D. BROCHET

Brochet is located on Reindeer Lake in the northwest corner of the province. It was selected as one of the expansion sites mainly for its isolation from industrial pollution sources, i.e. the usual predominant wind direction (NW) places Brochet upwind of both Manitoba smelters. It was envisioned as a background station which could provide data on precipitation quality entering the Province, and began operating on February 8, 1984. It has, however, provided sporatic operation caused in part by numerous mechanical breakdowns, and poor communication links.

The Atmospheric Environment Service does not operate any weather services in the Brochet area. Any A.E.S. precipitation data utilized for Brochet is from the two closest stations i.e. Lynn Lake, Manitoba (120 km south) and Collins Bay, Saskatchewan (130 km west north west). This data utilization creates a major assumption in that meteorological conditions experienced in Lynn Lake or Collins Bay are also assumed to occur in Brochet. The failure of this assumption is reflected directly on the collection efficiency, which is the ratio of precipitation collected to the amount that fell.

During the report, with this assumption in place, Brochet received a total precipitation fall of 448 mm from 181 events. The analyzable fraction however was 426 mm from 112 events. The M.N.P.C. collector collected 3.1 litres from 17 events for a precipitation fall of 48.3 mm or a collection efficiency of 12.1%. A three month breakdown during the months of May to August significantly influenced the data collected at this station.

The pH values of the limited samples collected ranged from a low of 4.29 (October 18) to a high of 5.73 (February 11) with an overall volume-weighted mean pH of 4.74. Monthly averaged mean pH values present no discernible trends due in part to the substantial missing data.

The volume-weighted mean sulphate was 1.33 mg/L with a corresponding wet sulphate deposition of 5.96 Kg/ha/yr.

A mean nitrate value of 0.59 mg/L was calculated for the Brochet area.

No trends in these parameters can be ascertained due in part to the limited data collected and the fact that this station had not completed a full year of operation.

E. POINTE DU BOIS

The monitoring equipment at Pointe du Bois is located on Winnipeg Hydro property. This station, is similar to Brochet in terms of availability of A.E.S. meteorological data. However, the two nearest reporting stations (Pinawa 32 km south west, Great Falls 48 km north west) are much closer in this instance and the extrapolation assumption is more realistic than that for the Brochet site. This station began operation January 2, 1984.

During the report period, the two A.E.S. stations reported an average of 609 mm of precipitation from 116 events. The analyzable fraction translated to 600 mm from 91 events. The M.N.P.C. instrument collected 234.5 litres from 64 events which translates to a

precipitation fall of 384.6 mm for a collection efficiency of 64.3% and a representative collection efficiency of 63.1% utilizing all precipitation that fell. Of the total precipitation that fell, 470.8 mm (77.3%) fell during the months of May to October with June reporting the highest fall of 183.9 mm (30.2%). The smallest reported precipitation fall of 12.4 mm (3.0%) was recorded for the month of March.

Rainfall accounted for approximately 50% of the events collected while snowfall accounted for 22%. The remaining 19 events or 29.6% were a combination of these events or a different type.

The ability of the sampler to collect snowfall compared to rainfall in this instance is reversed. A 94.0% efficiency during the winter season of November to April was calculated compared to a 61.8% collection efficiency for rainfall during the summer months of May to October.

The pH values at this station ranged from a low of 4.25 (November 16) to a high of 7.15 (August 20) with a calculated volume-weighted mean pH of 5.08. Monthly averaged pH values shown in Appendix D appear to show a pH range between 5.0 and 5.5 with fluctuations to the high and low sides throughout the year.

The volume-weighted mean sulphate value for Pointe du Bois was calculated to be 0.93 mg/L with a corresponding wet sulphate deposition of 5.64 Kg/ha/yr. A mean nitrate value of 0.83 mg.L was calculated for the same period.

Mean values of eight parameters calculated through the reporting period indicates that sulphate was the dominant species. The order of predominance for the reporting period is as follows:

$$SO_4 > Ca > NH_3 > NO_3 > Cl > K > Na > Mg$$

VI. CONCLUSIONS

The following conclusions are based on the data collected from the M.N.P.C. network during the 1984 period:

1. The volume-weighted mean pH values decreased slightly at both Norway House and Island Lake. The volume-weighted mean pH values at the remaining stations i.e. Gillam, Brochet and Pointe du Bois appear to be in a similar pH range.
2. The wet sulphate deposition decreased at both Norway House and Island Lake during the report period.
3. On a province-wide basis the sulphate deposition values are below the established "effects" value of 20 kilograms per hectare per year as established by eastern jurisdictions.
4. In all monitoring locations the predominant parameter on a yearly averaged mean was sulphate with calcium in all but one station being the second most predominant parameter.

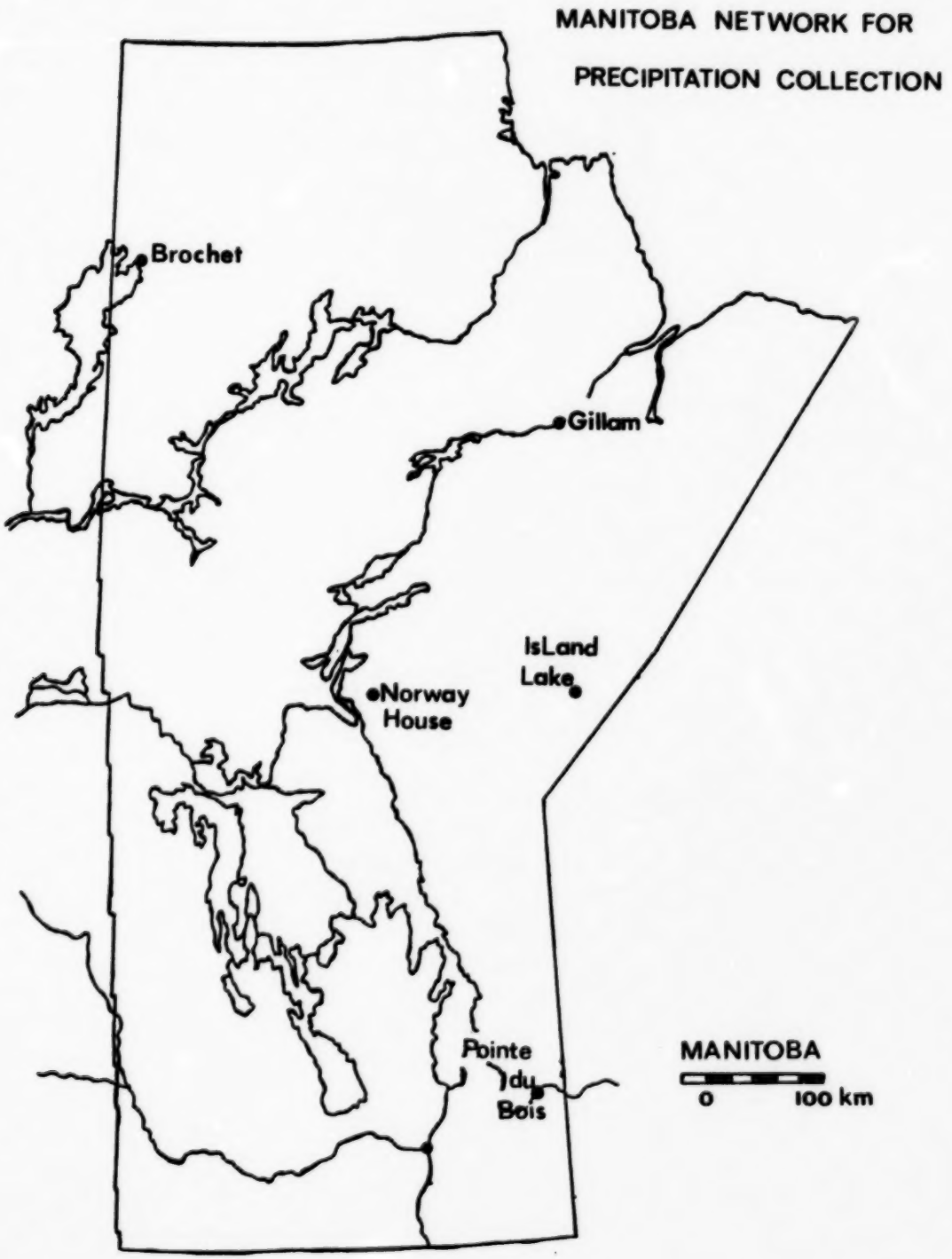
GLOSSARY OF TERMS

Glossary of Terms

STN	MNPC reference to identify sampling sites 7414 - Island Lake 7524 - Norway House 7614 - Gillam 7714 - Brochet 8204 - Pointe du Bois
COL-DATE	Date of sample removal from sampler (the actual collection period is from 0800 h from the previous date to 0800 h of the date shown).
STD-PPT	The actual amount of precipitation in mm (water equivalent for snow) as determined by standard precipitation gauge measurements.
pH	pH of the precipitation in pH units.
H^+	hydrogen ion content in micro equivalents per litre (calculated from pH).
SP-COND	specific conductance (μmhos/cm).
ACIDITY	milligrams per litre (mg/L) as $CaCO_3$
SULFATE	milligrams per litre
T-NIT-N	nitrate and nitrite as milligrams nitrogen per litre
AMMONIA-N	ammonia as milligrams nitrogen per litre
CALCIUM	mg/L
MAGNESIUM	mg/L
SODIUM	mg/L
CHLORIDE	mg/L
ALKALINITY	mg/L (as $CaCO_3$)
VOLUME	volume of sample received by the laboratory within the collection bag (millilitres).
ION-BAL	ionic balance expressed as a percentage (cations-anions) x 100
•	missing or unavoidable data (insufficient sample volume).
<	less than

APPENDIX A

PRECIPITATION MONITORING LOCATIONS (M.N.P.C.)


MANITOBA NETWORK FOR
PRECIPITATION COLLECTION
Brochet
Gillam
IsLand
Lake
Norway
House
Pointe
du
Bois
MANITOBA
0
100 km

APPENDIX B

DAILY PRECIPITATION SUMMARY

PRECIPITATION DATA SUMMARY -- ISLAND LAKE -- JAN. TO DEC. 1984

COL_DATE	STD_PPT	E_TYPE	E_CHAR	E_NAT	PH	H+	SP_COND	ACIDITY	SULFATE	T_NIT_N	AMMONIA_N	CALCIUM	MAGNESIUM	SODIUM	CHLORIDE	POTASSIUM	ALKALINITY	VOLUME	ION_BAL
					--	--													
84/01/03	9.2	6	.		5.55	2.80	.	1.43	<.20	.07	.027	.02	<.005	<.02	.15	<.01	.	575.0	29.65
84/01/05	4.4	6	.		4.84	14.34	.	2.23	.70	.11	.069	.04	.010	.12	.20	.08	.	174.5	2.29
84/01/07	1.4	6	.		5.67	2.12	.	1.11	<.20	.02	.010	.	.	.	.05	.	.	40.5	.
84/01/08	.6	.	.		.	.	.	.	.20	.02	.009	.02	.020	.	.10	.	.	23.8	.
84/01/24	3.0	6	.		5.43	3.69	.	1.44	<.20	.14	.040	.10	.010	.03	.10	.02	.	114.0	8.96
84/01/25	1.4	6	.		.	.	.	.	1.60	.28	.190	.70	.220	.34	.	.	.	16.5	.
84/01/26	.6	6	.		5.25	5.58	5.25	1.76	1.50	.04	.020	.04	.010	.00	5.00	.56	.	75.4	49.61
84/02/01	1.0	6	.		.	.	.	.	.40	.13	.040	.18	.030	.05	.15	.02	.	24.5	.
84/02/03	2.8	6	.		5.62	2.38	.	1.22	.20	.04	.020	.08	.025	.04	<.10	.01	.	114.0	9.33
84/02/04	.2	6	.		.	.	.	.	.30	.03	.	.04	.025	.11	.15	.04	.	17.1	.
84/02/05	2.0	6	.		5.59	2.55	.	1.22	.20	.01	.010	.03	.015	.05	<.10	.03	.	89.9	7.50
84/02/06	2.4	6	.		5.02	9.47	.	1.40	.30	.18	.030	.09	.015	.03	.10	.03	.	79.5	6.00
84/02/16	5.0	6	.		5.31	4.86	3.22	1.46	.20	.08	.030	<.02	<.005	.02	.20	.01	.	309.0	23.83
84/02/22	.	3	.		4.39	40.41	.	3.88	.	.28	.050	.	.	.	.20	.	.	47.8	.
84/03/10	1.8	6	.		.	.	11.40	.	1.80	.15	.000	.	.	.	.40	.	.	15.9	.
84/04/12	.5	3	3		4.06	86.41	52.10	6.85	.	.73	.	.	.	.	.	.	.	43.5	.
84/04/26	4.6	3	2		4.89	12.78	9.47	2.29	1.10	.09	.100	.16	.040	.06	.10	.06	.	226.0	4.79
84/04/27	.8	4	2	02	.	.	8.79	.	1.00	.14	.150	.	.	.	.40	.	.	20.6	.
84/04/28	19.8	6	2		5.55	2.80	3.76	1.37	.50	.04	.000	.11	.020	.03	.10	.03	.	436.0	4.89
84/04/29	10.8	.	.		5.51	3.07	3.59	1.37	.30	.07	.100	<.02	<.005	.04	.05	.01	.	415.0	3.73
84/05/07	11.4	3	2		5.51	3.07	6.48	1.42	.80	.20	.190	.24	.040	.06	.15	.05	.	568.6	3.20
84/05/08	2.6	3	2		.	.	5.22	.	.50	.03	.038	.13	.025	.	.30	.	.	23.6	.
84/05/09	5.7	3	2		5.01	9.69	6.53	1.77	.80	.01	.033	.04	.010	.02	.10	.02	.	245.0	10.76
84/05/11	1.0	3	2		4.44	36.02	20.40	3.35	1.60	.11	.140	.13	.020	.	1.00	.	.	46.9	.
84/05/18	6.0	1	1	11	7.19	.06	24.30	1.74	1.20	.12	.070	3.30	.550	.06	.20	.27	.	175.0	70.28
84/05/19	.7	2	1		.	.	6.84	.	.	.07	.000	.13	.030	.12	.30	.16	.	24.3	.
84/05/21	8.8	3	2		5.26	5.45	4.69	1.74	.40	.03	.040	.03	.005	.03	.10	.04	.	521.0	2.83
84/05/22	.6	3	1		.	.	3.87	.	.80	.08	.070	.14	.045	.	.25	.	.	24.3	.
84/06/01	6.4	3	1		4.84	14.34	11.20	2.53	.80	.14	.240	.22	.045	.05	.10	.10	.	411.0	26.70
84/06/07	6.2	.	.		4.80	15.72	9.80	3.08	1.00	.12	.100	.12	.035	.00	.20	.20	.	356.0	7.09
84/06/08	2.8	.	.		4.73	18.47	10.60	2.92	1.00	.10	.170	.04	.015	.00	.15	.12	.	150.0	11.37
84/06/09	7.2	3	1		4.74	18.05	9.42	2.76	1.10	.10	.120	.05	.010	.02	.10	.06	.	381.0	.09
84/06/18	16.0	2	2		4.82	15.02	8.09	1.67	.40	.07	.080	<.02	<.005	.02	<.10	.02	.	1010.0	18.65
84/06/19	3.2	3	2		5.38	4.14	3.18	1.59	.40	.02	.020	<.02	<.005	.03	<.10	.04	.	170.0	14.92
84/06/20	1.0	3	1		4.38	41.36	9.31	2.29	.	.06	.	.	.	.	.35	.	.	57.4	.
84/06/22	6.6	3	1		4.57	26.70	13.70	3.63	.70	.22	.200	.06	.010	.05	.10	.04	.	406.0	18.44
84/06/23	32.3	1	1		4.58	26.09	11.70	3.63	.70	.11	.140	.03	.005	.04	<.10	.03	.	1040.0	23.25
84/06/24	9.2	3	1		4.75	17.64	8.42	2.70	.70	.04	.040	<.02	<.005	.06	<.10	.06	.	270.0	10.61
84/06/26	13.8	3	1		4.85	14.01	14.90	2.73	.80	.10	.170	.03	.005	.03	<.10	.02	.	904.0	-5.86
84/07/01	1.6	3	1		4.46	34.40	25.20	3.39	2.00	.38	.560	.50	.120	.14	.20	.14	.	106.0	23.07
84/07/02	28.2	3	1		4.99	10.15	6.92	1.45	.70	.07	.130	.08	.025	.03	<.10	.03	.	1830.0	-10.41
84/07/04	6.2	3	1		4.69	20.26	14.90	3.22	1.10	.05	.060	<.02	.005	.03	.10	.03	.	345.0	2.14
84/07/06	1.6	3	1		4.66	21.70	10.20	2.66	.50	.06	.100	.	.	.	.20	.	.	56.8	.
84/07/14	3.4	3	.		4.69	20.26	28.40	5.35	1.50	.24	.240	.41	.080	.04	.10	.09	.	263.0	14.51
84/07/15	8.8	3	1		5.17	6.71	8.81	1.78	.30	.07	.100	.04	.015	.02	<.10	.04	.	500.0	14.92
84/07/17	6.0	3	2		5.65	2.22	10.10	<1.00	.40	.08	.030	.02	.005	.10	.10	.09	.	355.0	15.10
84/07/19	.	.	.		5.56	2.73	12.50	1.10	.80	.24	.450	.71	.170	.04	.10	.07	.	173.0	41.12
84/07/23	2.8	3	1		4.38	41.36	25.30	3.79	2.10	.23	.380	.39	.085	.27	.30	.17	.	107.0	23.48
84/07/26	.	.	.		5.09	8.06	9.88	1.09	.50	.02	.020	<.02	<.005	.02	<.10	.03	.	375.0	7.76
84/08/05	2.8	3	1		4.86	13.69	30.60	2.26	1.60	.21	.430	.17	.040	.04	.10	.10	.	180.0	-8.45
84/08/06	7.2	3	1		5.26	5.45	15.10	1.29	.90	.15	.260	.05	.010	.03	<.10	.04	.	475.0	4.12

PRECIPITATION DATA SUMMARY -- ISLAND LAKE -- JAN. TO DEC. 1984

COL_DATE	STD_PPT	E_TYPE	E_CHAR	X_MAT	PH	H+	SP_COND	ACIDITY	SULFATE	T_NIT_N	AMMONIA_N	CALCIUM	MAGNESIUM	SODIUM	CHLORIDE	POTASSIUM	ALKALINITY	VOLUME	ION_BAL
84/08/08	12.0	1	1		4.74	18.05	21.30	3.80	.50	.12	.200	<.02	<.005	.04	<.10	.08	.	766.0	-26.58
84/08/10	6.4	3	2		5.46	3.44	4.75	1.61	.20	.02	.020	<.02	<.005	.05	<.10	.05	.	190.0	7.32
84/08/17	3.8	3	1		5.00	9.92	12.00	2.35	.80	.17	.250	.20	.040	.08	.15	.06	.	213.0	15.15
84/08/22	6.2	3	2	01	5.54	2.86	5.44	1.18	.40	.06	.100	.05	.010	.07	.10	.06	.	730.0	-7.44
84/08/26	15.4	1	1	03	5.10	7.88	14.70	2.46	.	.19	.310	.24	.055	.08	.	.09	.	76.3	.
84/08/30	1.4	.	.		6.37	.42	5.47	1.13	.60	.03	.080	.40	.085	.11	.30	.13	.	94.0	33.38
84/08/31	1.2	3	1		5.09	1.28	5.02	1.35	.	.01	.050	.	.	.	.30	.	.	58.0	.
84/09/04	2.4	3	1		4.98	10.39	9.77	1.85	.20	.04	.320	<.02	.005	.06	.10	.06	.	150.0	59.58
84/09/08	17.6	3	2		4.61	24.35	17.90	3.79	1.00	.14	.290	.24	.025	.03	.10	.03	.	920.0	9.82
84/09/11	1.0	3	1		4.82	15.02	17.40	2.39	1.10	.08	.120	.	.	.	.15	.	.	52.8	.
84/09/13	12.5	3	2		5.32	4.75	2.97	1.44	.20	.02	.020	<.02	<.005	.03	<.10	.02	.	886.0	5.60
84/09/18	2.2	3	1		5.22	5.98	15.50	1.88	1.60	.22	.290	.41	.123	.09	.15	.19	.	152.0	-21.88
84/09/20	1.6	.	.		4.64	22.73	13.40	2.69	1.20	.08	.050	.16	.045	.13	.25	.12	.	89.4	-10.63
84/09/22	6.2	3	2	03	5.54	2.86	5.44	1.18	.40	.06	.100	.05	.010	.07	.10	.06	.	730.0	-7.44
84/09/23	28.6	3	2		5.30	4.97	5.60	1.59	.20	.05	.080	.07	.005	.03	.05	.03	.	782.0	29.18
84/10/03	2.6	.	.		5.32	4.75	8.75	1.34	.70	.02	.040	.10	.010	.33	.45	.27	.	105.0	9.47
84/10/12	20.6	1	1		5.96	1.09	15.10	1.19	2.80	.33	.970	.49	.075	.04	.25	.06	.	1310.0	8.03
84/10/17	8.4	3	2		4.26	54.32	33.40	4.60	3.30	.25	.310	.05	.005	.02	<.10	.03	.	521.0	4.73
84/10/18	2.8	3	2		4.68	20.73	15.10	2.74	1.60	.07	.140	.03	<.005	.09	<.10	.11	.	157.0	2.60
84/10/26	6.0	6	2		5.20	6.26	6.24	1.00	.30	.17	.060	.11	.025	.06	.10	.07	.	213.0	-3.02
84/10/27	1.4	3	3		5.00	9.92	13.40	1.65	1.60	.34	.460	.05	.010	.15	.	.21	.	90.2	.
84/11/01	3.6	6	.		4.79	16.09	10.60	2.84	.60	.29	.070	.10	.025	.04	.10	.02	.	113.0	8.42
84/11/04	2.2	.	.		5.49	3.21	5.90	1.39	.60	.31	.130	.32	.055	.02	<.10	.03	.	130.0	3.85
84/11/09	5.0	6	2		5.04	9.05	7.09	1.53	.40	.35	.100	.21	.020	.03	<.10	.02	.	114.0	9.00
84/11/10	.	6	2		4.94	11.39	6.42	2.11	<.20	.20	.050	.03	<.005	.02	<.10	.03	.	165.0	6.94
84/11/15	7.7	6	2		4.93	11.66	6.76	1.35	.45	.12	.050	.02	.005	<.02	<.10	<.01	.	384.0	7.74
84/11/16	5.3	6	2		5.16	6.86	5.54	1.34	.20	.15	.020	<.02	<.005	<.02	.10	<.01	.	154.0	24.03
84/11/26	16.8	6	2		5.08	8.25	5.28	1.06	.40	.09	.100	<.02	<.005	.02	.10	.01	.	857.0	.94
84/11/27	2.2	6	2		4.18	65.35	35.10	5.50	.	.90	.340	.	.	.	.	.	.	53.6	.
84/11/28	11.6	6	2		4.67	21.21	11.10	2.59	.60	.16	.050	.03	<.005	.04	.05	.03	.	397.0	6.80
84/12/11	.	6	.		5.07	8.44	7.62	1.45	.	.23	.120	.	.	.	.	.	.	60.0	.
84/12/21	2.2	6	2		5.14	7.17	7.48	2.00	<.20	.15	.020	.	.	.	.	.	.	58.0	.
84/12/22	2.4	6	2		4.64	21.70	14.30	2.17	.70	.43	.	.20	.030	.	.20	.	.	104.0	.

PRECIPITATION DATA SUMMARY -- NORWAY HOUSE -- JAN. TO DEC. 1984

COL_DATE	STD_PPT	E_TYPE	E_CHAR	X_MAT	PH	H+	SP_COND	ACIDITY	SULFATE	T_NIT_N	AMMONIA_N	CALCIUM	MAGNESIUM	SODIUM	CHLORIDE	POTASSIUM	ALKALINITY	VOLUME	ION_BAL
84/01/03	.	6	.	10	5.27	5.33	.	2.39	.40	.09	.100	.09	.015	.22	.30	.03	.	234.6	10.33
84/01/15	.	6	.	10	5.25	5.58	.	1.76	.30	.17	.040	.25	.050	.04	.15	.03	.	107.0	22.59
84/01/23	.	6	.	11	5.84	1.43	.	1.09	.40	.11	.070	.24	.050	.06	.10	.04	.	168.0	-15.90
84/01/24	.	6	.	23	5.86	1.37	.	1.98	.40	.04	<.020	.20	.000	.03	.20	.10	.	205.0	16.02
84/01/28	.	6	.		5.46	3.44	.	1.52	.20	.05	.020	.03	.010	.06	.	.04	.	60.4	.
84/02/02	.	6	.		5.31	4.86	.	1.37	.40	.05	.020	.04	.005	.02	.05	.01	.	233.0	15.03
84/02/04	.	6	.		.	.	.	.10	.02	.02	.010	.03	.010	.05	.10	.03	.	54.2	.
84/02/14	.	6	.		5.11	7.70	6.44	2.11	.50	.12	.060	.15	.020	.05	.10	.02	.	101.0	-4.45
84/02/22	.	6	.		5.00	9.92	7.11	1.69	.60	.08	.020	.09	.015	.03	.10	.02	.	160.0	5.29
84/03/23	.	6	.		5.42	3.77	.	1.46	1.50	.17	.350	.30	.025	.03	<.10	.02	.	200.0	1.60
84/03/25	.	6	.		4.85	14.01	5.96	2.27	1.70	.32	.480	.23	.	.	.	.	.	47.2	.
84/03/27	.	5	.		.	.	17.00	.	2.20	.57	1.000	.26	.035	.10	.15	.08	.	32.1	.
84/03/28	.	5	.		4.49	32.10	26.10	3.88	2.70	.49	.900	.10	.015	.10	.15	.07	.	83.8	6.60
84/04/07	.	.	.		7.00	.10	44.70	2.39	4.90	1.24	1.700	3.80	.800	.25	.50	.30	.	84.4	31.86
84/04/11	7.6	3	.		4.66	21.70	17.10	3.34	1.90	.38	.440	.20	.040	.18	.20	.19	.	470.0	5.56
84/04/12	2.2	3	.		4.78	16.46	12.10	2.87	1.20	.20	.260	.10	.010	.17	.25	.14	.	105.0	5.68
84/04/13	2.8	3	.		4.42	37.72	23.50	3.98	2.60	.34	.430	.10	.020	.29	.50	.20	.	143.0	.22
84/04/25	4.6	3	.		5.68	2.07	3.56	1.58	.50	.06	.150	.10	.020	.02	<.10	.03	.	282.0	9.26
84/04/26	5.6	4	.	11	5.37	4.23	.	1.74	.90	.09	.011	.	.	.	<.10	.	.	52.6	.
84/04/28	.	6	.	23	5.95	1.11	2.00	1.74	.30	<.01	<.002	.19	.035	.02	<.10	.03	.	185.0	21.90
84/05/05	1.0	6	2		5.45	3.52	4.76	1.58	.70	.05	.040	.	.	.	.15	.	.	58.7	.
84/05/16	.6	2	1	09	.	.	54.30	.	6.80	1.60	1.900	4.60	.850	.	.70	.	.	29.8	.
84/05/17	.8	3	1	09	.	.	25.30	.	3.20	.65	.790	2.20	.345	.	.65	.	.	37.9	.
84/05/18	7.2	3	2	11	5.09	1.28	3.94	1.90	.60	.08	.050	.28	.065	.06	.40	.15	.	409.0	1.93
84/05/21	9.8	3	2	11	5.77	1.68	3.80	1.90	.60	.03	.020	.16	.035	.05	.15	.19	.	539.0	5.44
84/05/22	2.4	3	1	11	5.48	3.29	4.02	2.37	.80	.04	.050	.06	.030	.08	.20	.17	.	82.9	10.99
84/05/23	3.6	3	2	30	4.88	13.08	9.33	2.53	1.20	.03	.050	.05	.015	.07	.20	.08	.	204.0	12.48
84/06/07	12.0	3	2	16	5.65	2.22	4.74	2.76	1.20	.05	<.020	.18	.060	.11	.20	.46	.	320.0	4.66
84/06/08	6.2	3	1	11	6.15	.70	12.00	5.52	2.20	.08	1.100	.02	.020	.12	.15	.56	.	357.0	29.16
84/06/10	20.0	3	1		4.75	17.64	9.64	2.55	1.60	.18	.010	.15	.040	.09	.15	.08	.	153.0	12.24
84/06/23	2.4	3	2		4.18	65.55	37.40	5.91	3.80	.33	.380	.42	.085	.15	.20	.25	.	87.4	10.50
84/06/25	10.4	3	2		4.49	32.10	15.00	4.52	1.70	.19	.400	.18	.060	.04	.10	.11	.	670.0	20.96
84/06/27	1.2	3	1		4.66	21.70	12.40	2.36	.	.07	<.020	.	.	.	.20	.	.	57.1	.
84/07/05	18.0	3	1		5.24	5.71	4.99	2.36	.50	.05	.050	.06	.040	.04	.20	.22	.	130.0	7.84
84/07/08	3.0	3	1		5.14	7.19	11.20	2.32	1.30	.28	.490	.42	.100	.05	.20	.07	.	174.0	-17.73
84/07/12	4.2	3	.		4.72	18.90	10.60	1.86	.80	.12	.050	.07	.010	.02	<.10	.06	.	188.0	-1.99
84/07/14	13.6	.	.	11	5.05	8.84	11.10	2.12	.80	.13	.140	.11	.020	.04	<.10	.06	.	831.0	-.93
84/07/15	6.2	1	1	03	5.02	9.47	7.68	1.43	.70	.11	.220	.19	.030	.03	.10	.04	.	234.0	26.04
84/07/16	5.2	3	1	16	6.16	.69	12.00	1.70	2.50	.05	1.000	.02	.020	.11	.30	.25	.	11.0	14.64
84/07/21	1.4	.	.		6.27	.53	15.40	1.01	.	.36	.480	.	.	.	.80	.	.	62.1	.
84/07/23	1.6	.	1		6.32	.47	8.87	1.19	.	.05	.490	.	.	.	.40	.	.	60.0	.
84/07/25	3.6	3	2		6.13	.74	7.37	1.29	1.20	.06	.330	.20	.060	.16	.35	.15	.	292.0	12.27
84/08/05	24.0	3	2		5.25	5.58	6.20	2.00	.50	.09	.160	.04	.005	.02	<.10	.04	.	1535.0	4.10
84/08/08	10.6	3	2	11	5.62	2.38	5.62	1.09	<.20	.11	.140	.07	.020	.03	<.10	.08	.	720.0	-10.28
84/08/09	5.1	3	2	19	5.79	1.61	2.90	.44	<.20	.03	.020	.05	.010	.04	.10	.07	.	11.0	-4.10
84/08/17	5.0	3	2		5.85	1.40	5.78	.98	.50	.14	.220	.12	.030	.09	.10	.08	.	249.0	15.24
84/08/20	2.2	3	1		5.90	1.25	26.70	1.78	3.40	.82	1.100	.	.	.	.30	.	.	81.7	.
84/08/21	3.4	3	1		5.54	2.86	2.64	1.13	.20	<.01	<.020	.06	.010	.03	.20	.11	.	166.0	-2.15
84/08/30	8.4	3	2		6.36	.43	6.61	.97	.	.03	<.020	.49	.135	.24	.65	.31	.	74.0	.
84/09/08	20.8	3	2		4.72	18.90	15.80	2.93	1.90	.15	.280	.10	.010	.03	.10	.04	.	1275.0	5.43
84/09/13	6.6	3	2		5.52	3.00	2.99	1.53	.30	.04	.070	.03	.005	<.02	.05	.01	.	109.0	2.47

PRECIPITATION DATA SUMMARY -- NORWAY HOUSE -- JAN. TO DEC. 1984

COL_DATE	STD_PPT	E_TYPE	E_CHAR	E_NAT	PH	H+	SP_COND	ACIDITY	SULFATE	T_NIT_N	AMMONIA_N	CALCIUM	MAGNESIUM	SODIUM	CHLORIDE	POTASSIUM	ALKALINITY	VOLUME	ION_BAL
						--													
84/09/20	3.0	3	1	11	5.06	8.64	8.09	1.75	.40	.06	.030	.18	.035	.14	.40	.19	.	122.0	16.92
84/09/22	3.4	5	2	22	5.96	1.09	10.30	2.50	1.20	<.01	<.020	.43	.160	.09	.70	1.80	.	23.0	-31.46
84/09/23	8.2	5	2	22	5.77	1.68	9.01	2.93	1.70	.04	<.020	.43	.170	.05	.70	.95	.	154.0	-12.83
84/10/12	4.7	3	2		4.87	13.38	21.30	2.62	3.80	.38	1.000	.22	.045	.06	.30	.10	.	152.0	4.30
84/10/14	29.2	3	2		4.17	67.07	35.00	4.99	3.60	.22	.210	.07	.020	.04	<.10	.08	.	1100.0	1.29
84/10/17	46.4	3	2	66	4.87	13.38	7.40	1.89	.90	.03	.040	.03	<.005	.10	<.10	.05	.	627.0	-.19
84/10/18	15.4	3	2	66	4.96	10.88	7.62	1.61	.70	.05	.040	.02	<.005	.02	<.10	.05	.	583.0	9.57
84/10/26	.	6	2	66	5.79	1.61	2.57	<1.00	<.02	.05	<.020	.04	.005	.02	<.10	.02	.	128.0	26.61
84/11/08	.	6	2	11	5.09	8.06	29.60	2.11	3.20	1.74	1.300	1.64	.130	.	.30	.	.	69.0	.
84/11/11	.	6	2		5.73	1.85	6.95	<1.00	1.20	.21	.100	.45	.100	.40	.20	.08	.	109.0	-19.26
84/11/15	.	6	2	11	5.23	5.84	4.27	<1.00	<.20	.06	.030	.03	.010	<.02	.20	.01	.	290.0	1.17
84/11/25	.	6	2		5.50	3.14	2.63	1.14	<.20	.02	.040	.03	.005	.02	<.10	.01	.	350.0	-3.56
84/11/26	.	6	2		4.97	10.63	7.18	1.63	.40	.14	.060	.11	.020	.05	.10	.03	.	200.0	5.15
84/12/06	.	6	-1		6.66	.22	26.30	<1.00	<7.00	.	<.020	.	.	.	.	.	.	38.0	.
84/12/19	1.0	6	1		5.43	3.69	6.98	2.62	.90	.25	<.010	.	.	.	.10	.	.	59.9	.

PRECIPITATION DATA SUMMARY -- BILLAH -- JAN. TO DEC. 1984

COL_DATE	STD_PPT	E_TYPE	E_CHAR	E_MAT	PH	H+	SP_COND	ACIDITY	SULFATE	T_NIT_N	AMMONIA_N	CALCIUM	MAGNESIUM	SODIUM	CHLORIDE	POTASSIUM	ALKALINITY	VOLUME	ION_BAL
84/01/07	.	6	.		.	.	.	.	.30	.10	<.030	.16	.045	.	.10	.	.	21.7	.
84/01/05	.	6	.		5.45	3.52	.	1.59	<.20	.02	.007	.04	<.005	.06	.05	.03	.	139.6	16.72
84/02/08	.	6	.		4.43	36.86	.	3.41	.80	.38	.050	.05	.005	.06	.10	.02	.	103.0	.11
84/02/21	.	6	.		.	.	15.10	.	.	.33	.060	1.24	.005	.08	.20	.05	.	35.6	.
84/03/19	.	6	.		6.21	.61	60.80	1.79	2.60	.20	.300	1.34	.	.	14.00	.	.	71.0	.
84/04/12	.	3	.		.	.	.	.	4.40	.46	.	.32	.085	.30	.30	.13	.	22.8	.
84/04/25	.	.	.		5.91	1.22	14.00	1.42	1.20	.13	.260	.39	.150	.09	.20	.09	.	98.5	15.91
84/04/26	.	6	3		4.89	12.78	10.20	2.07	1.00	.18	.130	.31	.075	.07	.15	.03	.	97.6	11.31
84/06/18	5.0	3	1	29	6.94	.11	37.00	<1.00	2.40	.14	.010	5.60	.650	.13	.50	.52	.	174.0	65.32
84/06/29	.	.	.	11	6.58	.26	17.90	1.44	2.80	.31	.010	1.94	.485	.23	.40	.29	.	65.6	25.73
84/07/03	2.4	1	1	06	6.95	.11	12.50	1.05	.90	.09	.140	1.62	.335	.04	.20	.06	.	797.0	59.66
84/07/04	4.4	1	1		4.50	31.37	20.20	3.79	1.70	.21	.240	.20	.050	.06	.30	.12	.	457.0	7.48
84/07/18	.2	1	1		5.83	1.47	8.13	1.69	1.30	.06	.080	.82	.205	.08	.20	.09	.	215.0	31.38
84/07/23	.	.	.	11	6.10	.79	27.40	1.30	3.20	.39	.640	1.37	.360	.14	1.00	.45	.	241.0	-13.89
84/07/30	.	.	.		7.39	.04	34.60	.51	1.30	.15	.110	6.30	.800	.08	.20	.12	.	350.0	80.20
84/08/08	4.6	3	3		4.75	17.64	28.30	4.20	1.30	.22	.250	.11	.025	.11	.20	.14	.	380.0	-3.07
84/08/20	1.4	3	1		6.57	.27	24.30	2.04	3.10	.58	.790	1.71	.400	.39	.50	.30	.	140.0	25.12
84/08/21	3.6	3	1		.	.	7.31	.	.20	.05	.030	.87	.260	.28	.	.22	.	55.7	.
84/08/24	.4	3	1	05	6.32	.47	11.90	1.19	1.60	.26	.170	1.07	.295	.08	.25	.09	.	185.0	24.01
84/09/04	6.9	3	1		5.00	9.92	9.56	1.79	1.60	.04	.090	.26	.060	.18	.15	.13	.	280.0	5.90
84/09/07	.2	2	3		6.56	.27	17.30	1.17	2.80	.45	.860	1.08	.270	.08	.25	.11	.	248.0	17.91
84/09/09	12.8	3	2		5.72	1.89	28.30	1.33	2.00	.23	.440	.45	.380	2.90	5.10	.28	.	220.0	-4.39
84/10/19	.4	3	2		6.47	.34	20.00	<1.00	1.20	.18	.070	.91	.390	1.70	3.30	.21	.	84.1	10.69
84/11/13	.	6	3		6.26	.55	5.69	<1.00	.60	.19	.100	.	.	.	.20	.	.	59.0	.
84/11/16	.	6	2		5.49	3.21	2.67	<1.00	<.20	.02	.004	.03	.005	.06	<.10	.02	.	262.0	-.71
84/12/04	.	6	3		5.96	1.09	2.77	<1.00	.20	.02	.020	.18	.050	.07	.20	.02	.	66.2	20.80
84/12/21	.	6	3		5.47	3.36	6.24	<1.00	.45	.16	.030	.38	.100	.09	.20	.02	.	66.9	-16.75

PRECIPITATION DATA SUMMARY -- BROCHET -- JAN. TO DEC. 1984

COL_DATE	STD_PPT	E_TYPE	E_CHAR	E_MAT	PH	H+	SP_COND	ACIDITY	SULFATE	T_DIT_N	AMMONIA_N	CALCIUM	MAGNESIUM	SODIUM	CHLORIDE	POTASSIUM	ALKALINITY	VOLUME	ION_BAL
84/02/11	.	.	.		5.73	1.85	.	1.29	.60	.10	.080	.39	.025	.06	.10	.01	.	167.0	-17.50
84/02/29	.	6	.		.	.	3	.	.60	.04	.050	.93	.	.	.	.	.	26.7	.
84/03/26	.	6	.	05	5.48	3.29	2.96	1.42	.20	.02	.040	.03	.005	.04	<.10	.04	.	344.8	12.54
84/04/07	.	3	.	05	5.33	4.64	5.33	1.39	.60	.09	.270	.10	.015	.02	.20	.02	.	250.0	9.75
84/04/10	.	3	.		4.75	17.64	15.10	2.71	1.80	.24	.450	.20	.035	.07	.10	.03	.	515.0	7.36
84/09/12	.	3	3	06	4.64	22.73	14.00	2.00	.90	.03	.020	.09	.035	.13	.20	.16	.	97.1	21.80
84/09/18	.	3	3	06	5.05	8.84	7.12	1.18	.30	.06	.040	.05	.005	.03	.05	.05	.	313.0	-18.07
84/09/27	.	6	1		4.43	36.86	25.00	3.48	1.60	.40	.220	.	.	.	.30	.	.	61.1	.
84/10/02	.	6	3		4.88	13.00	11.90	1.77	1.30	.19	.260	.12	.015	.05	.40	.08	.	178.0	9.22
84/10/05	.	.	1		4.58	26.09	29.10	3.15	3.00	.34	.230	.	.	.	.70	.	.	36.6	.
84/10/15	.	3	1		4.87	13.38	16.00	1.85	1.90	.21	.460	.25	.025	.16	.30	.19	.	150.0	8.79
84/10/18	.	3	2		4.29	50.88	32.40	3.99	3.20	.17	.230	.07	.010	.02	<.10	.02	.	570.0	4.52
84/10/27	.	6	3		5.40	3.29	10.30	<1.00	.40	.04	.090	.04	<.005	.02	.	<.01	.	70.3	.
84/11/08	.	6	2		5.34	4.53	2.66	1.04	.20	.04	.030	1.18	.230	.	.60	.	.	80.5	.
84/11/26	.	3	3	05	5.15	7.02	4.70	1.24	.40	.03	.030	.06	<.005	.04	.15	.03	.	74.8	4.00
84/12/06	.	6	2	05	5.29	5.09	3.12	<1.00	<.20	.04	.020	.02	<.005	.15	.10	.10	.	93.2	-26.70
84/12/21	.	6	.		5.09	8.06	4.20	1.42	<.20	.08	.030	.	.	.	.	.	.	57.6	.

PRECIPITATION DATA SUMMARY -- POINTE DU BOIS -- JAN. TO DEC. 1984

COL_DATE	STD_PPT	E_TYPE	E_CHAR	X_MAT	PH	H+	SP_COND	ACIDITY	SULFATE	T_NIT_N	AMMONIA_N	CALCIUM	MAGNESIUM	SODIUM	CHLORIDE	POTASSIUM	ALKALINITY	VOLUME	ION_BAL
84/01/05	6.0	.	.		6.24	.57	.	1.59	.	.	.	.	.	.	.	.	.	32.9	.
84/01/16	.	6	.		5.59	2.55	.	1.60	<.20	.16	.030	.21	.050	.06	.10	.03	.	70.0	16.31
84/01/23	.	6	.		5.04	9.05	.	2.00	.20	.29	.080	.25	.050	.35	.50	.19	.	71.5	13.83
84/01/24	.	6	.		5.56	2.73	.	1.44	.80	.12	.140	.22	.035	.11	.15	.	.	61.6	.
84/01/26	.	6	.		5.42	3.77	.	1.60	.20	.10	.040	.07	.015	.11	.10	.06	.	90.7	11.22
84/01/28	.	6	.		4.82	15.02	.	2.29	.40	.27	.100	.09	.020	.07	.10	.05	.	105.0	3.54
84/01/30	.	6	.		.	.	.	.	.20	.17	.030	.18	.030	.07	.30	.03	.	46.4	.
84/02/03	.	6	.		5.27	5.33	.	1.83	.40	.20	.070	.14	.030	.12	.40	.05	.	162.0	12.60
84/02/13	.	6	.		.	.	.	.	.50	.30	.050	.14	.010	.20	.20	.10	.	30.1	.
84/02/16	.	3	.		5.00	9.92	11.50	2.10	.90	.36	.300	.19	.020	.10	.10	.06	.	409.0	-1.22
84/02/17	.	6	.		4.90	12.49	9.91	1.94	.60	.18	.160	.03	<.005	.04	<.10	.04	.	463.0	-.82
84/03/10	.	.	.	09	6.89	.13	20.70	1.79	1.50	.62	.300	2.32	.535	.11	.30	.09	.	85.0	38.40
84/03/11	.	3	.	09	6.66	.22	24.80	2.11	2.70	.92	.660	1.80	.710	.14	.70	1.90	.	178.0	18.90
84/03/15	.	6	.		4.86	13.69	12.90	2.27	.70	.43	.310	.16	.020	.07	.20	.03	.	570.0	1.56
84/03/26	.	3	.		5.02	9.47	42.20	3.88	.	1.76	2.700	.92	.	.	1.15	.	.	58.9	.
84/04/25	1.2	2	2		.	.	15.30	.	1.20	.39	.750	.73	.145	.39	.60	.20	.	55.8	.
84/04/28	37.5	3	.	09	6.64	.23	9.72	1.27	1.40	.12	.190	1.09	.105	.16	.25	.09	.	2120.0	31.63
84/05/19	4.0	2	3	27	6.51	.31	5.48	1.27	.60	.07	.050	.54	.130	.06	.20	.05	.	197.0	32.55
84/05/20	2.0	3	3		5.60	3.95	5.30	1.30	.30	.10	.100	.11	.020	.12	.30	.12	.	116.0	1.02
84/05/31	3.0	3	.		6.25	.56	10.60	1.90	1.10	.31	.360	.69	.125	.22	.60	.26	.	237.0	16.98
84/06/06	10.2	4	2	03	4.97	10.63	12.60	2.43	1.20	.11	.090	.15	.025	.50	.70	.12	.	137.0	1.09
84/06/07	50.0	3	3		5.38	4.14	4.08	2.11	.50	.09	.110	.05	.010	.07	<.10	.07	.	3017.0	1.30
84/06/08	32.2	2	2		5.13	7.35	7.06	2.60	.30	.17	.160	.05	.010	.05	<.10	.07	.	1150.0	1.43
84/06/09	16.4	3	3		4.91	12.21	7.51	2.20	.60	.19	.150	<.02	<.005	.03	.10	.05	.	966.0	3.45
84/06/13	8.4	.	2		4.86	13.69	7.31	2.11	.40	.15	.040	<.02	<.005	.03	.10	.04	.	499.0	3.67
84/06/17	6.0	3	1		4.72	18.90	13.20	1.37	1.40	.36	.270	.15	.045	.09	.15	.11	.	224.0	2.52
84/06/22	2.6	2	3		4.61	24.55	18.30	2.26	1.50	.44	.330	.20	.065	.14	.20	.14	.	171.0	6.93
84/06/23	11.0	3	1		5.29	5.09	6.75	1.63	.70	.16	.120	.15	.040	.10	.20	.17	.	686.0	-2.38
84/06/24	8.2	.	.		4.75	17.64	5.30	1.79	.80	.63	.020	.03	.010	.06	.20	.09	.	405.0	3.72
84/06/27	33.5	1	1		5.20	6.26	4.40	1.38	.20	.06	.030	.03	.010	<.02	<.10	<.01	.	2110.0	2.56
84/07/05	2.4	3	1		6.14	.72	9.60	1.33	.70	.03	.	.38	.130	.	.	.	.	49.8	.
84/07/06	.8	.	.		5.93	1.17	4.09	<1.00	.30	.05	.260	<.02	.010	.09	.30	.15	.	158.0	13.34
84/07/13	16.0	3	3	11	5.11	7.70	10.70	1.48	1.40	.34	.340	.44	.080	.09	.30	.14	.	916.0	6.79
84/07/14	2.0	3	1		4.88	13.00	10.80	2.47	1.10	.29	.130	.34	.075	.27	.40	.20	.	141.0	9.12
84/07/15	2.2	3	1	06	6.02	.95	6.45	1.96	.40	.02	.030	.24	.070	.40	.60	.48	.	86.9	30.90
84/07/17	1.0	3	1		6.22	.60	20.40	1.17	.	.20	.260	.	.	.	.	.	.	49.1	.
84/07/26	37.0	3	1		6.00	.83	3.70	.45	.30	.08	.120	.24	.055	.02	.20	.05	.	1280.0	22.94
84/07/31	2.6	.	.		4.34	45.35	29.30	3.35	2.60	.68	.620	.11	.020	.04	.10	.06	.	145.0	2.58
84/08/10	1.8	3	3		5.29	5.09	8.09	1.61	.	.04	.190	.09	.025	.	.10	.	.	62.1	.
84/08/20	4.6	3	3	17	7.15	.07	30.60	2.20	1.40	.19	3.200	.20	.085	.41	1.00	.59	.	6.0	59.46
84/08/25	4.0	1	1		4.97	10.63	15.40	1.63	2.00	.50	.500	.40	.070	.07	.20	.12	.	220.0	2.90
84/08/26	1.4	3	2		6.42	.38	25.80	2.24	.	.61	1.500	1.14	.265	.54	.	.80	.	74.0	.
84/09/04	.	.	.		6.73	.18	14.80	1.74	1.40	.06	.980	.19	.090	.43	.60	.74	.	281.0	42.53
84/09/07	.	.	.		5.75	1.76	40.20	4.38	8.40	.88	2.600	.95	.195	.64	.85	.87	.	130.0	7.07
84/09/09	7.6	3	1		5.75	1.76	13.10	4.46	1.20	.12	.980	.17	.030	.07	.10	.08	.	470.0	41.49
84/09/10	2.4	2	1		5.06	8.64	8.37	3.02	.40	.03	.060	.08	.020	.20	.20	.18	.	90.1	32.80
84/09/11	4.2	3	1		5.46	3.44	6.52	3.29	<.20	.03	.180	.03	.015	.65	.25	.59	.	195.0	-41.73
84/09/13	17.8	3	1		4.84	14.34	9.64	6.82	.60	.10	.090	.06	.010	.06	<.10	.06	.	249.0	12.32
84/09/15	4.0	3	1	30	5.69	3.21	5.11	1.67	.80	.03	.200	.03	.005	.04	.10	.08	.	6.0	-3.56
84/09/22	4.2	3	1	26	6.45	.35	36.20	2.58	3.60	1.38	1.300	2.40	.455	.12	.40	.50	.	11.0	-12.27
84/09/25	3.0	4	2		5.19	6.41	6.37	1.29	.60	.09	<.010	.	.	.	.20	.	.	62.4	.

PRECIPITATION DATA SUMMARY — POINTE DU BOIS — JAN. TO DEC. 1984

COL_DATE	STD_PPT	E_TYPE	E_CHAR	I_MAT	PH	H+	SP_COND	ACIDITY	SULFATE	T_NIT_N	AMMONIA_N	CALCIUM	MAGNESIUM	SODIUM	CHLORIDE	POTASSIUM	ALKALINITY	VOLUME	ION_BAL
84/09/26	.	6	.		5.10	6.25	10.10	1.93	1.60	.10	.490	.	.	.	.30	.	.	60.0	.
84/10/14	.	2	3		6.40	.39	24.90	1.47	4.30	.70	1.800	.90	.165	.21	.25	.27	.	87.9	17.29
84/10/16	25.0	3	2		4.77	16.85	11.60	3.27	1.40	.10	.130	.13	.025	.04	<.10	.05	.	1475.0	1.70
84/10/18	29.4	3	.		6.79	.16	9.36	<1.00	1.60	.07	.060	.08	.140	.50	<.10	.03	.	347.0	33.50
84/10/20	20.2	3	2		4.98	10.39	7.07	1.70	.60	.10	.030	.08	.020	.03	<.10	.05	.	550.0	3.88
84/10/21	3.4	.	.		5.32	4.75	4.72	1.25	<.02	.09	<.010	.02	.005	.06	<.10	.04	.	121.0	3.71
84/10/22	3.2	3	.		5.41	3.86	3.23	1.24	.	.04	.030	.02	.005	.12	.10	.12	.	85.7	.
84/10/25	2.2	6	.		4.79	16.09	15.70	2.72	.	.24	.310	.20	.050	.	<.01	.	.	78.1	.
84/10/29	.	3	.	66	5.30	5.14	8.74	1.34	1.30	.33	.370	.15	.030	.05	.10	.05	.	145.0	3.33
84/11/16	.	6	.		4.25	55.79	44.40	4.81	3.00	1.38	.900	.60	.070	.11	.30	.08	.	305.0	2.93
84/11/26	.	3	.		4.38	41.36	27.70	3.77	2.20	.74	.300	.28	.040	.21	.30	.14	.	94.3	.64
84/11/27	.	3	.		4.40	39.69	23.20	3.37	1.80	.66	.430	.06	.010	.10	.15	.11	.	352.0	1.96
84/12/17	.	6	2		5.68	2.07	6.42	1.66	.70	.17	.140	.16	.025	.02	.08	.02	.	500.0	0.89

APPENDIX C

STATISTICAL DATA SUMMARY

TABLE 1.0 SUMMARY OF DATA - M.N.P.C. - ISLAND LAKE - 1984

AES COUNT	MNPC COUNT	MIN. pH	MAX pH	MEAN pH	TOT/PRECIP (cm)	AVG. SO_4 (mg/l)	AVG. NO_3 (mg/l)	WET SO_4 DEP.*	COL. EFF.	REP. EFF.
91(136)	84	4.06	7.19	4.91	54.2	0.83	0.54	4.88	78.1	75.4

TABLE 2.0 SUMMARY OF DATA - M.N.P.C. - NORWAY HOUSE - 1984

AES COUNT	MNPC COUNT	MIN. pH	MAX. pH	MEAN pH	TOTAL PRECIP. (cm)	AVG. SO_4 (mg/l)	AVG. NO_3 (mg/l)	WET SO_4 DEP.*	COL. EFF.	REP. COLL.
99(152)	66	4.17	7.00	4.87	49.8	1.21	0.63	6.00	55.8	53.0

TABLE 3.0 SUMMARY OF DATA - M.N.P.C. - GILLAM - 1984

AES COUNT	MNPC COUNT	MIN. pH	MAX. pH	MEAN pH	TOTAL PRECIP. (cm)	AVG. SO_4 (mg/l)	AVG. NO_3 (mg/l)	WET SO_4 DEP.*	COL. EFF.	REP. COLL.
83(145)	27	4.43	7.39	5.17	39.2	1.48	0.82	5.80	22.0	20.7

* reported in kilograms/hectare/year

TABLE 4.0 SUMMARY OF DATA - M.N.P.C. - BROCHET - 1984

AES COUNT	MNPC COUNT	MIN. pH	MAX. pH	MEAN pH	TOTAL PRECIP. (cm)	AVG. SO_4 (mg/l)	AVG. NO_3 (mg/l)	WET SO_4 DEP.*	Coll. Eff.
112(181)	17	4.29	5.73	4.74	44.8	1.33	0.59	5.96	12.1

TABLE 5.0 SUMMARY OF DATA - M.N.P.C. - POINTE DU BOIS - 1984

AES COUNT	MNPC COUNT	MIN. pH	MAX. pH	MEAN pH	TOTAL PRECIP. (cm)	AVG. SO_4 (mg/l)	AVG. NO_3 (mg/l)	WET SO_4 DEP.*	COL. EFF.	REP. COLL.
91(116)	64	4.25	7.15	5.08	60.9	0.93	0.83	5.64	64.3	63.1

Where:

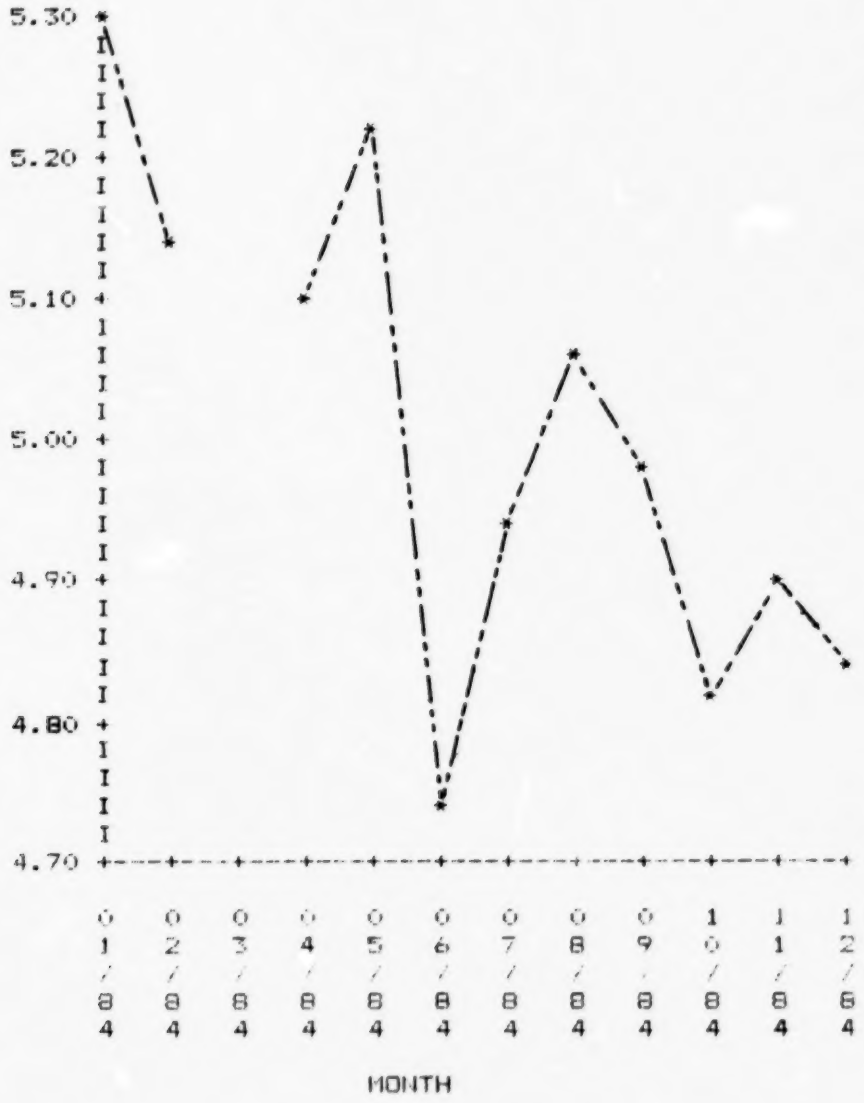
AES count = number of precipitation events recorded during the report period >0.8 mm. (Total number of precipitation events shown in parenthesis)
MNPC count = number of samples collected by precipitation gauge.
MIN. pH = minimum pH recorded for report period.
MAX. pH = maximum pH recorded for report period.
MEAN pH = volume-weighted mean pH
TOTAL PRECIP. (cm) = total precipitation collected by A.E.S. instruments >0.2 mm.
AVG. SO_4 = volume-weighted sulphate average.
AVG. NO_3 = volume-weighted nitrate average.
COL. EFF. = collection efficiency of MNPC collector expressed as a percentage of total precipitation.
REP. EFF. = collection efficiency of MNPC collector expressed as a percentage of A.E.S. catch greater than 0.2 mm

APPENDIX D

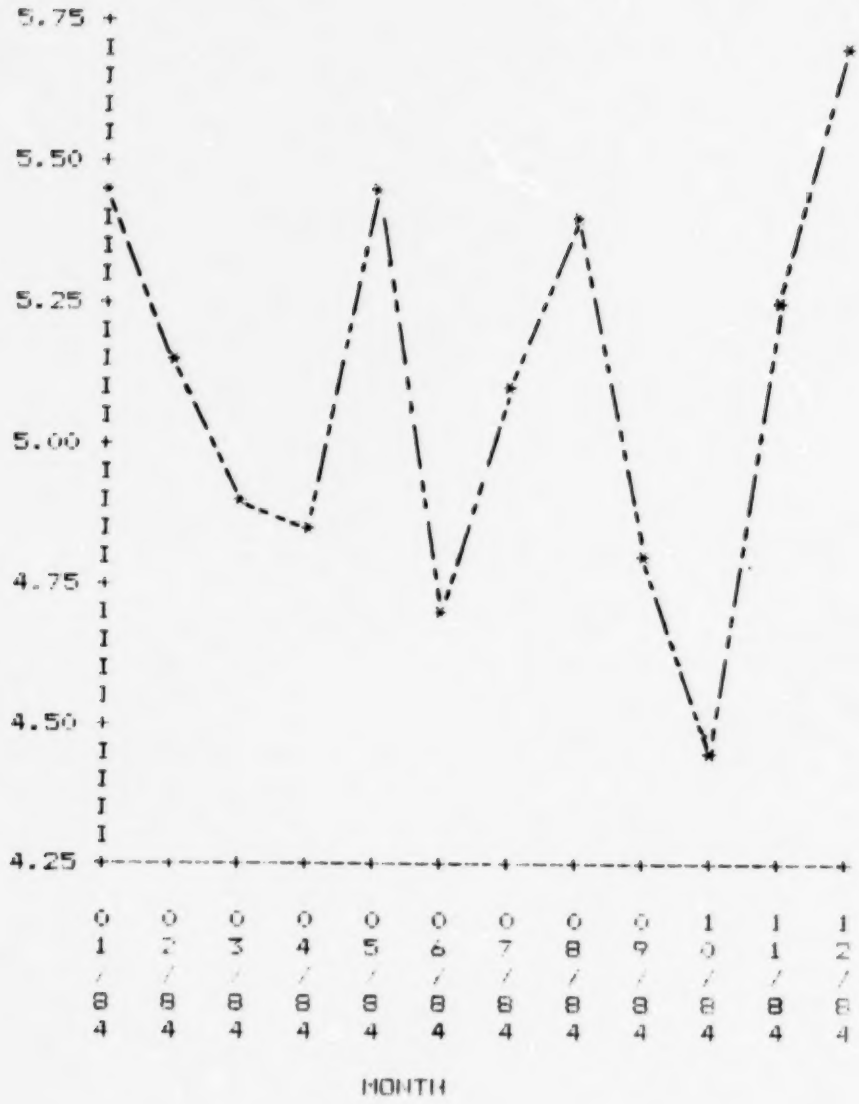
MANITOBA NETWORK FOR PRECIPITATION COLLECTION

MEAN pH VS MONTH (GRAPHIC) 1984)

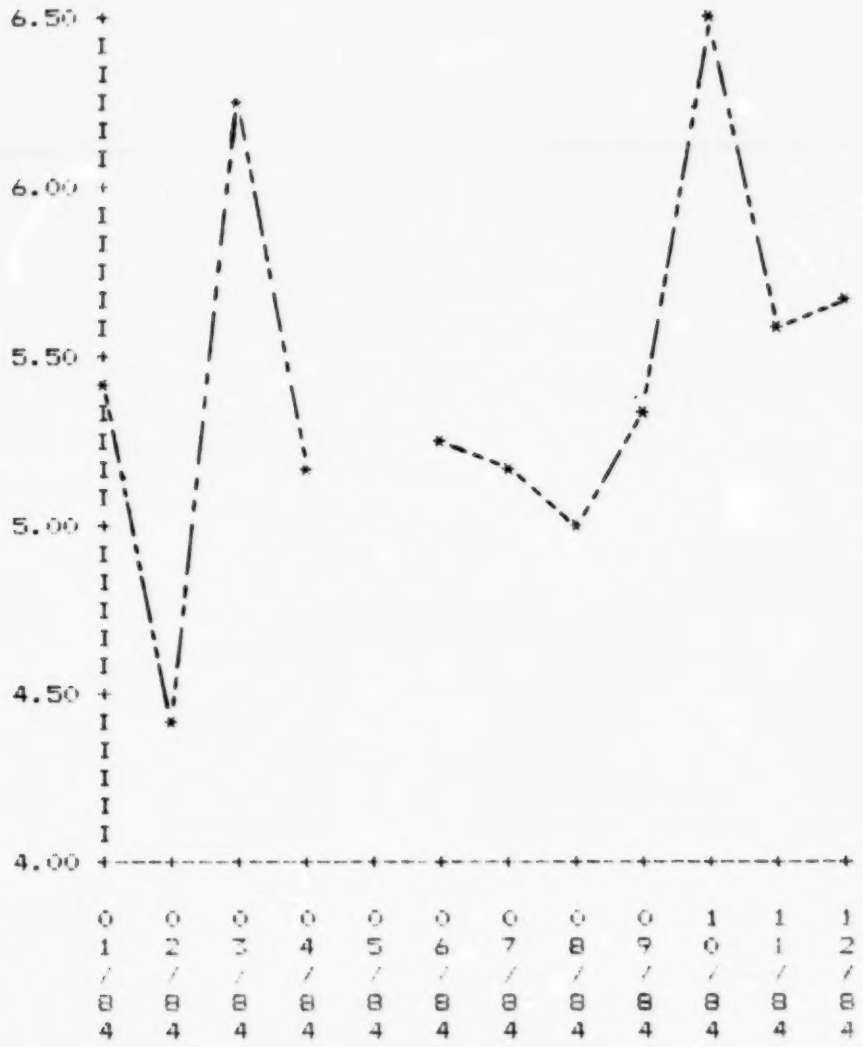
MEAN PH ---- ISLAND LAKE ---- 1984



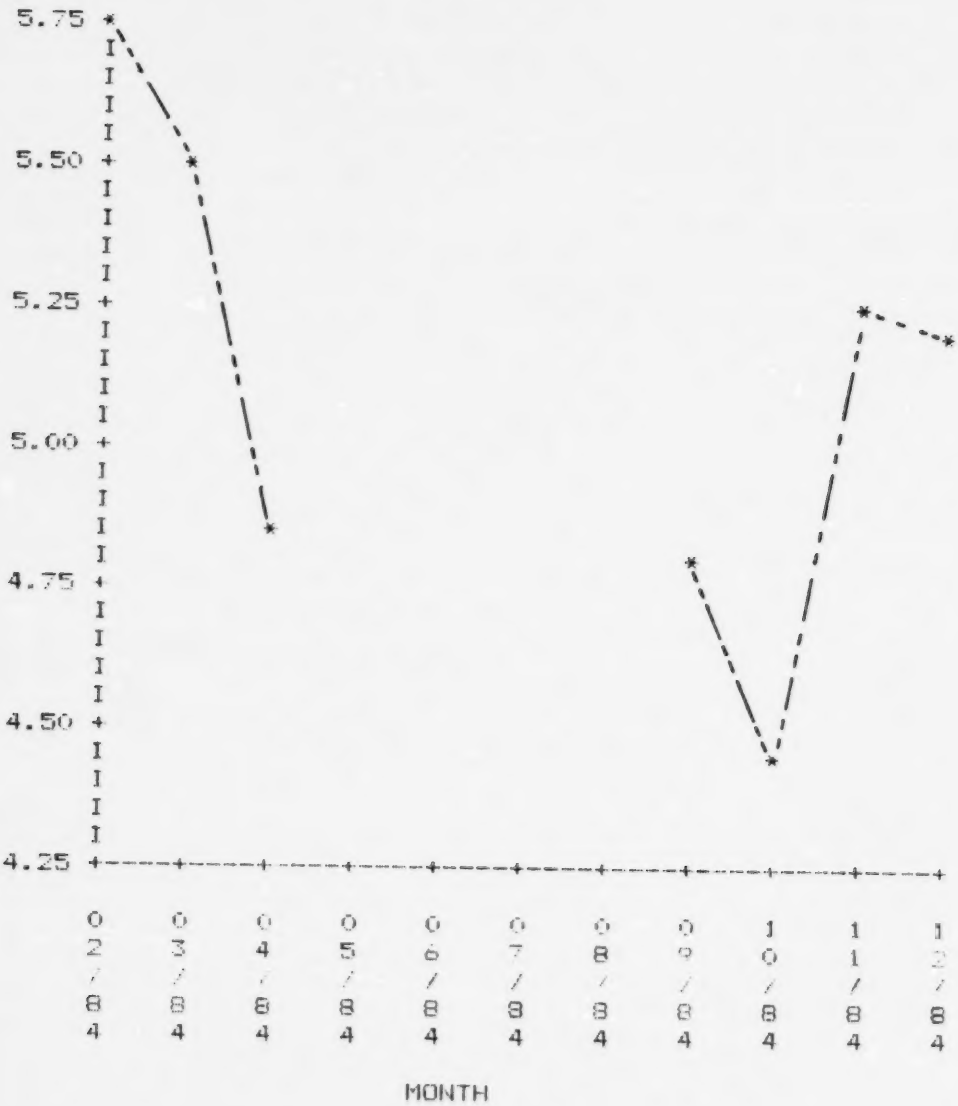
MEAN PH ---- NORWAY HOUSE ---- 1984



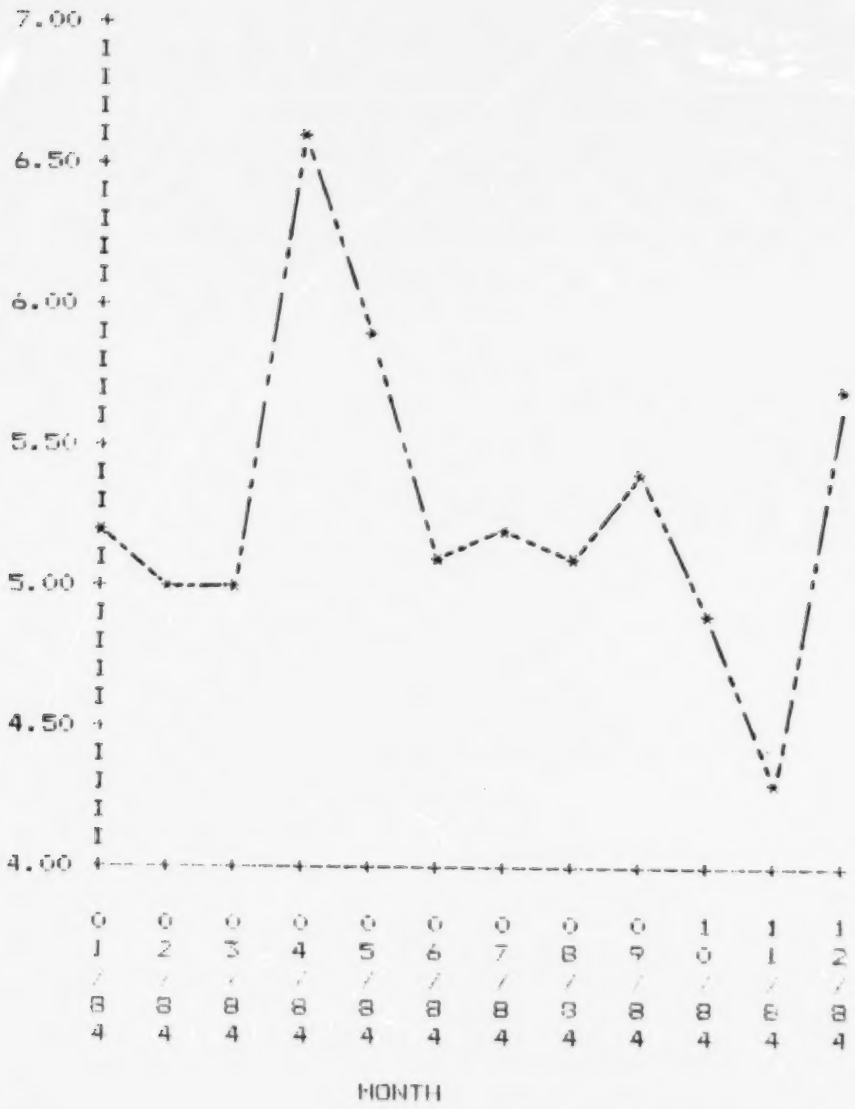
MEAN PH ---- GILLAM ---- 1984



MEAN PH ---- BROCHET ---- 1984



MEAN PH ---- POINTE DU BOIS ---- 1984



APPENDIX E

MANITOBA NETWORK FOR PRECIPITATION COLLECTION

DATA SUMMARY - 1980 - 1984

DATA SUMMARY - M.N.P.C. NETWORK - 1980 - 1984

Year/Location	Min pH	Max pH	Mean pH	Avg SO_4 mg/L	Avg NO_3 mg/L	Wet SO_4 Deposition kg/ha/yr
1980 Island Lake	4.34	5.00	4.79	0.69	1.12	N/A
Norway House	5.61	7.50	6.08	0.60	0.86	N/A
1981 Island Lake	3.02	6.73	4.47	1.61	0.68	7.63
Norway House	3.40	7.28	4.64	1.65	1.01	8.45
1982 Island Lake	4.00	7.00	4.42	1.52	0.70	8.65
Norway House	4.79	5.85	4.97	1.09	1.88	7.15
1983 Island Lake	4.09	6.58	5.06	1.27	0.81	7.66
Norway House	4.61	6.13	5.16	1.29	1.29	8.18
1984 Island Lake	4.06	7.19	4.91	0.83	0.54	4.88
Norway House	4.17	7.00	4.87	1.21	0.63	6.00
Gillam	4.43	7.39	5.17	1.48	0.82	5.80
Brochet	4.29	5.73	4.74	1.33	0.59	5.96
Pointe du Bois	4.25	7.15	5.08	0.93	0.83	5.64

APPENDIX F

PRECIPITATION EVENT TYPE CODE

CODE	EVENT TYPE
1.	Thunder
2.	Drizzle
3.	Rain
4.	Freezing Drizzle
5.	Freezing Rain
6.	Snow
7.	Snow Pellets
8.	Snow Grains
9.	Ice Pellets
10.	Hail
11.	Ice Crystals

APPENDIX G

EXTRANEOUS MATTER CODE (sample)

VISUAL INSPECTION

X-MAT Visual observations on the condition of the collected precipitation sample when received at the Analytical Laboratory.

Code	Explantion of Code
0	Sample in acceptable condition
1	Bag leaking at heat seal
2	Bag leaking at manufactures seal
3	Bag not sealed
4	Hole in bag
5	Sample is cloudy
6	Sample is colored
7	Vandalism to sample
8	Sample contains fine particulate
9	Sample contains medium particulate
10	Sample contains coarse particulate
11	Sample contains coagulated particulate
12	Sample contains sediment
13	Sample contains fish flies
14	Sample contains lady bugs
15	Sample contains spiders
16	Sample contains grasshoppers
17	Sample contains beetles
18	Sample contains leaves
19	Sample contains pineneedles
20	Sample contains pine cones
21	Sample contains twigs
22	Sample contains seeds
23	Sample contains unidentifiable plant material
24	Sample contains unidentifiable insects
25	Sample spilled
26	Multiday sample
27	Bulk sample (machine N/O)